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# BULLETIN *of*
# *The* GEORGIA ACADEMY *of* SCIENCE

Volume XIV | June, 1956 | Number 3

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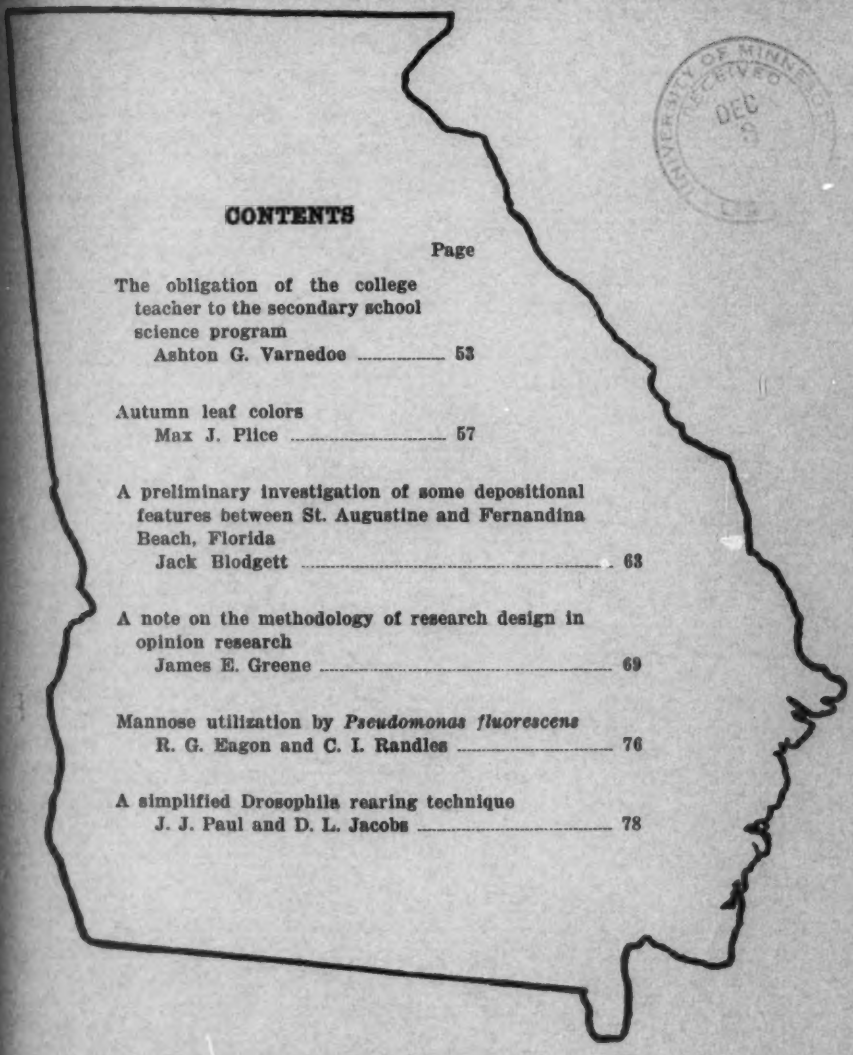

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# BULLETIN OF
# GEORGIA ACADEMY OF SCIENCE


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THE BULLETIN of the GEORGIA ACADEMY OF SCIENCE is published four times each year, in January, April, June and September and is sent without charge to all members of the Academy.

Articles to be published in the Bulletin should be sent to the Editor, Box 534, Emory University, Georgia. Reprints of articles can be furnished when ordered before publication.

# THE OBLIGATION OF THE COLLEGE TEACHER TO THE SECONDARY SCHOOL SCIENCE PROGRAM[1]

ASHTON G. VARNEDOE
Savannah High School

The title of this paper is perhaps misleading or at least vulnerable to attack for its suggests the inquiry—just why would a secondary teacher have the arrogance to presume the right to define the obligations of a college teacher?

Nevertheless the title is quite allowable and of real meaning at this particular time if we consider the basic meaning of education and the conditions the secondary teacher deals with today.

Perhaps one of the best conceptions of education is that of education as a leading out process in which the potentialities of one individual are encouraged to develop through the skill and understanding of another individual.

The individual who leads out another is a teacher and all teachers are of such stuff whether seminar leaders in the graduate schools of a great university or the kindergarten teacher in "Possum Hollow."

Such folk are all brothers and sisters under the skin.

This conception is not too widespread in actuality. There is a situation in the field of education that one sees often in geological situations, stratification and even abrupt discontinuity in a mass that should be homogeneous from bottom to top, at least in relation to the basic elements involved.

How does this apply to the subject of this paper? Quite simply as follows:

There is a deep and increasing necessity for all individuals concerned with education to come together in a confraternity, to meet together in the revealing light of an increasing understanding of the main purposes of their professional activities as teachers; to close ranks, now, and with insistent purpose, to demand that real and effective education not be allowed to drain away within our American schools.

The college teacher has the obligation to explore among the roots of the structure that supports the tall leafy top of his senior college seminars. He has the obligation to be intellectually curious about what the roots (the elementary schools) are doing and the stem (the secondary schools) are doing.

It is true that the chloroplasts are resident in the leaves trapping the sunlight of research and frontier knowledge and building up the new glucose for progressive intellectual feeding of our civilization; but it is just as true that the osmotic intake in the roots sup-

1. Paper read at the meeting of the Georgia Academy of Science, Science Education Section, April 28, 1956, Atlanta, Georgia.

plies much of the basic material that will be built into the educated individual.

And the lower schools are the roots and the fibro-vascular systems of the tree of education.

Do you realize what is happening at the roots and in the stem? Do you care?

The secondary science teacher has often been a lonely foot soldier fighting a losing battle in the war to gain understanding of the vital importance of science education to the youth of today.

The usual public school administrator has little conception of the physical environment needed to do a good job in the field of science education.

Education philosophy, sound within itself, but grossly distorted by many of its practitioners, has caused an increasing disinclination upon the part of students and, even more disturbing, upon the part of many parents, to pay the price of obtaining real understanding of science, mathematics and effectively learned english.

When one considers the complexities of the modern world and its increasing demands for full development of an individual's intelligence and character one is forced to the conclusion that much of our present practice is actually teaching dishonesty.

But students in many secondary schools no longer pay any attention to the Cassandra voices of those in the high schools who tell them honestly what they can expect in a college with decent standards.

The secondary teacher needs backing from the college teacher.

It would be an intelligent investment by colleges to send a field representative over the entire State of Georgia, not to sell a particular college, but simply to sell the following idea: that the most important investment that a young person could make would be investment of time and effort in laying a sound foundation for his education.

The college professor still has the prestige and may be listened to —but the high school teacher no longer has such a position of strength.

It may not be realized, by many people teaching upon the college level, what has happened to the secondary teacher within the last twenty years.

At one time the high school teacher was a highly respected individual, enveloped, for many people, in a mantle of superior knowledge. Today the same position carries little community prestige, relatively very poor pay and averages, in one teaching community, a time investment of fifty-four hours per week on the strictly professional job.

The above cited condition is definitely one of deterioration.

Where does the obligation of the college teacher come in?

The college teacher needs to support and help energize any effort by the secondary teacher to gain support for better salaries, more recognition of the importance of teaching and the elimination of much of the time consuming clerical work that is dumped upon the public school science teacher.

The financial reward of teaching is the most critical factor involved today as indicated by the end product of low pay which is causing men to be rapidly eliminated from the ranks of the public school science teaching force.

In the public school situation with which the author of this paper is most familiar, the male classroom teacher has dropped to less than ten percent in fields other than physical education. This is an extremely unhealthy situation and one that demands a vocal and increasing insistence that teaching salaries be brought up to a level that will attract and retain young men of ability, training and imagination.

But there is another aspect of the situation that confronts the secondary science teacher.

We are being bombarded from all sides with the statement that the secondary school is the critical level for discovery and energizing of the potential scientist, engineer, and future science teachers.

For one, I have never doubted, the vital importance of the secondary school; that is the reason why I am, after thirty years of teaching, still in the secondary school. It *is* a critical level. But what is disturbing and increasingly tiresome is the insistence of the demands by colleges, business, and industry that a job be done with little realistic discussion of some basic conditions that must be set up in order to get the job done.

From the mindset of a secondary teacher, I will throw out the following ideas:

1. If more college teachers would look into the need for some understanding of adolescent psychology there would be a greater chance of a meeting of minds. It could be possible that a good course in educational adolescent psychology could be of therapeutic value to many individuals teaching upon the college level.

2. College people could well consider the exploration of the teaching of a field as a major research necessity; better *Methods* in mathematics, chemistry, physics, biology and earth science could well engage the attention of the most eminent of scholars, providing the scholar is also versed in the psychology, history and philosophy of education. Perhaps more research papers by scientists dealing with the above phenomena would bear fruit of equal value with research less concerned with the human factor.

3. College teachers and scholars could well invest some time in producing *Materials* for instruction in various scientific fields but produced in the light of understanding of the psychology of the early adolescent.

4. The college teacher has an immediate and critical obligation to construct, teach and evaluate science courses for secondary and elementary teachers that will provide good sound scientific knowledge for these teachers without expecting them to fulfill the sequential program that a specialist in a narrowed field would take.

It is important to remember that the secondary science teacher must operate in many fields while the college specialist operates in a few fields. Construction of such courses is perhaps the most funda-

mental of the obligations of the college teacher to secondary science education.

5. The college teacher has an obligation to use his influence as a patron of the public schools to increase understanding of the real function of the secondary science teacher as well as to insist that science experiences for early adolescents be under the guidance of competent people.

The function of the secondary teacher should be that of helping the student discover vital interests in the physical and biological worlds of which he is part.

This is an intricate and demanding job that requires broad understanding of both human nature and scientific principles as well as ingenuity as a craftsman and time to do the basic job.

But today far too much of the science teacher's time is drained off into the mechanics of running a school; lunch room duty; hall patrol; committee work; school bank; graduation class sponsor and on down an amazing list of possible duties. All of these things must be done and many are even interesting to do but they are done at sacrifice of more effective science experiences for students.

Good ideas for better demonstrations die unborn; equipment improvement never gets done; pupil conference time goes by the board; films do not get previewed; field trips go down the drain and the science fair project idea does not get the early pupil-teacher analysis that it needs.

A defensible statement could well be that "science teacher" is a misnomer in many public schools today. As to provision by public schools of competent people to teach science we are all aware of the situation I am sure. Many people teaching science know little science and care little about science as a vital part of education.

Rectification of this particularly serious situation will not come about until salaries go up substantially and colleges provide those more creatively conceived courses referred to earlier in this paper and public school administrators and Boards of Education are made to realize the necessity to foster science education for young people.

It would seem that the Bill of Obligations listed so far in this paper would indeed be enough and in a sense too much for expectation of serious entertainment by any reasonable person.

But serious entertainment by his brother of the college level is exactly what the secondary teacher hopes for.

That this hope exists in the secondary teacher's mind and heart is rather an amazing phenomena in itself. Anyone enduring the discouragement and frustration experienced today by many secondary science teachers could well become hopeless.

Perhaps the reason that the hope exists at all is due to the fact that scattered through the faculties of various colleges are individuals who see and accept the obligations pointed out in this paper.

May this tribe increase in both number and in determination to gird their loins and strike the Philistines that carry the false and brazen image of anti-intellectualism.

In closing this paper I would like to make an apology to Section seven of the Georgia Academy of Science.

This paper has not a single footnote, quotes no statistical data and refers to no authoritative source so, in a sense, it is out of place.

But in defense, its opinions are based upon thirty years of secondary school teaching ranging from the seventh through the twelfth grade.

And last, but most important, the speaker has a deep conviction that effective teaching is still more an art than a science. It is a thing of passionate caring, as the prime mover behind knowledge and understanding.

I would like to actually close with a statement made in the style of the Nineteenth Century.

Cold logics sings a song as clear as crystal water sprung from some Olympian Spring. But passion? Passion sings a song that springs not from cold rock but from the warm caring by a human mind and heart.

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## AUTUMN LEAF COLORS

MAX J. PLICE

*Formerly with the Georgia State Department of Agriculture*

**The material in the present paper is taken from data obtained by the writer while he was a special student of the late Dr. Wilder D. Bancroft, internationally known colloid chemist at Cornell University. It is part of a major work which involves a protracted study of the effects of environment and heredity, and their inter-relationships, on plant growth. It was Dr. Bancroft's belief that pigmentation in vegetation was activated by enzymes of several kinds. However, it was not possible to isolate, or identify, any such enzyme or enzyme system.**

Fall is the favorite season of the year for many people. One of the reasons for this seasonal preference is the varied changes in foliar coloration which is so characteristic of autumn time. Strangely enough, the phantasmagoria of fall color changes has, seemingly, been noticed and appreciated more by poets and philosophers than by scientists. Many more words have been written by way of panegyrics on the beauty of foliar colors than have been devoted to the explanation of the mechanism of the phenomenon. This is, in part, readily understandable. Mainly the autumn kaleidoscope of color changes is still looked upon as a miracle and, actually, that is what it is. It might be asked that, if this is true, why should one try to explain it! The pessimist has said that the persistent effort of so-called modern minds to explain mysteries is one of the most naive and foolish activities indulged in by the puny human brain. To this imponderable the optimist replies that children, even when they are growing up, are allowed to make bunches of daisies or play at imitating the songs of birds, even if they know nothing of botany or ornithology. Therefore, we continue.

The purely physical colors of nature are those of the rainbow, namely, violet, indigo, blue, green, yellow, orange, and red, in order, from the short-wave end to the long-wave end of the visible spectrum. However, since leaf color is extremely multifarious, the names of the colors in the rainbow, alone, are entirely inadequate to cover the multiplicity of actual leaf colors. Therefore it is necessary to use artistic license and esthetic taste in choosing color terms which are more nearly descriptive of the entire gamut of such colors. Some of these terms are azure, blush, bronze, carmine, crimson, magenta, cuprous, mauve, purple, ruby, rufous, sienna, wine, etc. These colors, including their hues, shades, tinges, and tints aid in the use of word descriptions which are fairly strong in concrete suggestiveness and vivid in respect to the color images which they arouse in the mind.

The gem of color formation in vegetation is multi-faceted. Many pigments are involved and each pigment requires a set of individually specific conditions in order to develop fully. In general, such conditions are governed by both environmental and hereditary factors. The environmental factors concern themselves mainly with the nature of the climate and soil in which any plant grows. The hereditary factors involve, mainly, the genes and determiners in plant germplasm. Heredity determines the capability of any plant, or organism, to utilize environmental factors to a satisfactory extent in order to perpetuate and maintain its individuality. For example, certain tree species never develop roseate leaf colors no matter what their environments. These species involve those which do not develop reddish pigments and those which have high leaf-ash contents. Included in the former are all of the narrow-leaf evergreens; most of the broad-leaf evergreens; and all of the "leguminous trees." In the species having high leaf-ash contents, hackberry, American elm, white mulberry, pecan, etc., are examples. The high leaf-ash property is a hereditary one. On the other hand certain species including black gum, pin oak, sour wood, sugar maple, sumac, etc., develop glorious colors in most years, no matter where they are growing. But the degree and extent of their color development may vary considerably with the seasons. These species have only a medium to low leaf-ash content. Thus, there are seasons in which heredity and environment assist and resist each other, in a rather narrow "zone-of-tension" to produce vegetative coloration.

## Leaf Pigments

The normal color of most vegetation, from the beginning to near maturity, is green because of chlorophyll pigments. When maturity approaches, no matter how early, an enzyme, chlorophyllase, begins to form and destroy the chlorophyll. With the disappearance of the green color a yellowish color then begins to dominate owning to the presence of xanthophyll, flavene, and flavone pigments; carotene pigments are also present and may add a touch of ruby to the yellow. These yellowish pigments were present in the leaf plastids from the beginning but were masked by the strong green color of

the chlorophyll. If the leaves do not now begin to develop reddish colorations it is certain that, either no red pigment-forming substances are present or that they are suppressed by the alkaline ash elements, particularly potassium, calcium, and magnesium. The most important red-forming pigments are the anthocyanins and the tannin-like substances, polyhydroxyphenols. The formation of anthocyanins in foliage is increased with increased respiration, which process is activated by energy-rich substances, including sugars, plus sufficient phosphate and nitrogen. The phenolic pigments develop best with a sufficiency of sugars and phosphate and a minimum of nitrogen. Both of these kinds of pigments are amphoteric in nature and their acidic colors are mostly quite different from their neutral or alkaline colors. Anthocyanins, particularly, show the deepest red colors when activated in a fairly strong-acid medium, and their color wave lengths are in the long end of the spectrum. With decreasing acidity the wave length shortens and the colors, up to near neutrality, change to violet and bluish. The phenolic pigments change from reddish to purplish at weaker acidities than the anthocyanins and their tints and hues vary from the latter. The coloration of the leaves of a tree in autumn can thus be quite variegated. Leaves can vary in their amounts and proportions of the different pigments and in the various elements which develop or hinder pigmentation. It is possible that one-half of a single leaf can be highly colored and the other half not colored; or just color-spotted.

The phenolic pigments, which according to infra-red spectroscopy are of several different kinds, have the ability to make complex combinations with certain metallic ions, such as iron, to produce entirely new and different colors. In certain years they dominate the anthocyanins and when this occurs the colorations, while still beautiful, are not brilliant. This is particularly characteristic in some white oaks as evidenced in their subdued purples and violets.

After a time, with increasing leaf maturity, all roseate coloration begins to fade and the brown colors of late fall and winter now dominate. The anthocyanin pigments change mostly to colorless substances while the phenolic pigments change into "humins." These are tannins of various chemical and physical make-up. When all leaf cells are dead the final brownish leaf colors—those of winter—are due to the humins.

## Ash and Acid Contents of Tree Leaves

In general, leaves which are high in ash elements are low in acidity. Contrariwise, leaves which are low in ash elements are mostly higher in acidity. However, the ash contents of leaves fluctuate with the years, as do the colors of the leaves. Consequently certain tree species may have highly colored foliage one year and not another. It was found, in the present work, that "high-ash" years correspond to "wet-years" and drab leaf coloration. Conversely, "low-ash" years correspond to "dry-years," generally, and highly colorful autumns. Thus there is a direct correlation of the amount of available soil moisture present during the growing season with the amount of ash

which tree leaves will contain. The more ash that leaves contain the less acidic they are and therefore the less the development of roseate brilliance. Another element also enters the picture here. The amount of nitrogen taken up from the soil in wet, or high-ash, years is less, relatively, than in dry seasons. Deficient nitrogen supply results in less anthocyanin pigment formation. This is quite striking in certain wet years.

Still another element, in balanced proportion, is necessary indirectly for anthocyanin formation, namely, phosphorus. This element is used in the formation and distribution of sugars in leaves, and sugars supply energy for the respiration process, and pigment formation is a result of this process. The total amounts of phosphorus in leaves in years of excess soil moisture is usually but little more than that present in dry years. But, owing to the excess of alkaline elements present in wet years, an imbalance between these elements and phosphorus results so that there is actually a deficiency of the latter element. Therefore, both sugar and anthocyanin pigment formation are retarded. In the instances of both nitrogen and phosphorus it is not so much the total amounts of these elements present—rather it is their relative proportions to the total ash elements present that make for satisfactory pigment development. In arid and semi-arid regions trees seldom develop sanguine fall colors whether or not they belong to species which attain rich coloration in a more humid-temperature climate. In the drier, warmer regions the soils are mostly neutral to alkaline in reaction and tree leaves there contain a preponderance of alkali-forming elements. Therefore, leaf acidity is less in a dry climate than in a humid climate.*

If a proper procedure is used to determine leaf acidity it can be seen that, in most tree species, leaf acidity begins to increase in amount and intensity in the fall as soon as chlorophyll begins to disappear and continues through the stage of the most brilliant reds. With the beginning of the final fall colors (browns) the acidity either remains practically static or decreases somewhat. Exceptions to this pattern of acidity behavior have been found to be few. One exception is the sourwood tree (Oxydendrum arboreum) which becomes one of the most beautiful of all trees in autumn. The leaves of this tree are at maximum acidity, approximately pH 2, very soon after they come out in spring and decrease in acidity, gradually until complete maturity. Even then their acidity approximates pH 4, which is considered to be rather strong.

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*It is here believed that if leaf acidity is determined correctly the relationship of this property to ash content and pigment development can be corroborated by others. In the present study it was found that great discrepancies in acidity (pH) determinations will result if proper procedure is not followed. Leaves should be dried sufficiently so that they can be ground to powder form. A sufficient-size portion of this powder is placed in a suitable container. Then it is rapidly, but thoroughly, wetted with just enough distilled water, containing a drop or two of a neutral, non-polar, surface active agent, to make a thin paste. The electrodes should be hastily inserted and the reading made within a few seconds. Pre-soaking of the sample or prolonging these operations permits hydrolyzable bases, and other interfering substances to cause too high pH readings, i. e., to show too little acidity present.

## Conditions Necessary for Maximum Leaf Coloration

From the observation of ecological and phenological conditions over a period of more than a quarter century it is here believed that, for the formation and maximum development of colorful autumns all growing conditions for pigment formation and development must be favorable. For this, in addition to soil moisture, ash elements, leaf acidity, etc., proper temperature and light are necessary. Sunlight, both in duration and intensity, influences all of the biological processes going on in a tree. During the time in which the roseate color-producing pigments are forming and developing, especially, great activity is going on inside the leaves. Acids, carbohydrates, proteins, fats, vitamins, auxins, and organo-mineral substances are being formed, transformed, translocated, and absorbed. None of the intricate processes which involve pigments could function efficiently if any unfavorable factor became operable at a vital moment of this metabolism. To much or too little of anything, including heat, light, moisture, minerals, or other nutrients or conditions, would constitute an unfavorable factor.

Shade is a condition which can interfere with the various metabolic processes and retard, or prevent, pigment development. For example, the Florida dogwood tree is near the top of the list of shade-tolerant trees and in autumn its leaves assume much color in degrees of shade that would entirely prevent pigment development in the leaves of most other tree species. Yet this dogwood sometimes finds itself in such shady places that its leaves have no possibility of revealing their propensity for taking on high color.

Temperature also influences all of a tree's life processes. The optimum temperature approximates that of "normal" for any vicinity, with no extreme fluctuations. Extremes in any factor militate against maximum color formation, particularly if they occur after about August 1. The dates here given are approximate for latitude 40, east of the Rocky Mountains.

Soil moisture should be sufficient in spring, and up to midsummer, to supply the root zone of trees with one-half to three-fourths of its water holding capacity. After this, soil moisture should decrease until by about September 1 when it should be at about one-third of the saturation point. By about October 1 the soil should be about one-fifth saturated and not decrease or increase significantly in moisture from that time on.

From about August 1 there should be insolation (sunshine) at least half of that possible; the more the better, providing that the necessary minimum of soil moisture is maintained. It is not known here, exactly, just what light rays are most helpful in pigment development at this time of the season but it is presumed that infrared light is since the incidence of sunlight to the earth in the northern hemisphere is becoming flatter each day. Further, it was noticed that periods of haze from this time on interfere with foliage coloration. Haze scatters sunlight, thus accentuating ultra-violent light which, seemingly, affects pigmentation adversely.

Temperature should, like the other factors, follow a close normal, without fluctuations. Colorful autumns have sometimes been explained by writers of popular articles as being due to "periods of cool, fall weather" which are at once followed by "periods of Indian Summer weather." There are elements of fact in this saying. However, these "magic" periods are inoperative if previous seasonal conditions have not been favorable.

Cool weather is not necessary in any of the involved pigmentation processes unless, perhaps, soil moisture is below optimum. Then it would decrease transpiration which would result in a more economical use of the moisture. Frost and freezing temperatures injure or kill plant tissues and thus do not aid in color development. Indian Summer weather can assist color development if this period has been preceded by cool, to cold, weather which retarded normal color development.

Americans traveling in Europe have noticed, perhaps, that autumnal coloration there is not so striking to the eye, or imagination, as in the United States. This drabness is believed by some to be due to the short duration of the daylight hours there at that time. The main reason for this, however, is that most of the trees in Europe are of species which are high in leaf ash or are non-pigment formers. There are some American pin oaks scattered around Europe and this tree becomes as colorful there, usually, as it does in the United States.

### Lawn Trees, Shrubbery and Color

It is the laudable desire of many home dwellers to have bright, colorful yards and gardens. For this purpose, flowers, shrubs, and trees are used. It is not generally known that, by manipulating the acidity or alkalinity of the soil, variegations in some flower and leaf colors may be brought about. Such manipulation sometimes proves to be undesirable in the case of colorful trees. Many shade trees, whose leaves normally color-up delightfully in autumn, have been ruined in this regard by overzealous lawn care, particularly, if the soil is very sandy. Some soils are so well balanced in the proportions of minerals which they contain that the addition to them of certain liming and fertilizing materials can upset that balance to the detriment of the trees—at least in so far as pretty leaf color is concerned. Burned lime (quick lime) and hydrated lime (water slaked lime) may be quite harmful in this, and other, connections. Further, the use of too much readily available nitrogen can cause trees to form leaves which are so "lush" that they will not develop the necessary pigments for ideal coloration. Therefore, a knowledge of how all soil amendments and fertilizing materials function should be obtained before these things are lavished on any lawn or garden.

The writer is acquainted with an instance where the owner of several magnificent specimens of Crimson Maple trees sprinkled table salt liberally under two of them—as a "fertilizer." These trees have never been "crimson" since. Instead, their leaves are dull-green in summer and in autumn they turn a clear "aspen-leaf gold"; still pretty, but far from being crimson colored.

It is unknown whether, or not, pigments play a functional part in the life of plants. It is quite possible, however, that they were not developed by Mother Nature solely to produce autumn colors for the delight and esthetic appreciation of man. Presumably, since most of them and particularly the phenolic pigments, have rather strong anti-septic properties they have roles as protective agents in plant growth. Further, the flavonoid pigments are being studied in biochemistry because they are now believed to possess anti-virus properties. It does not matter whether the pigments play dual roles or not. Both laymen and scientists are happy that they exist.

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## A PRELIMINARY INVESTIGATION OF SOME DEPOSITIONAL FEATURES BETWEEN ST. AUGUSTINE AND FERNANDINA BEACH, FLORIDA

JACK BLODGETT
Emory University

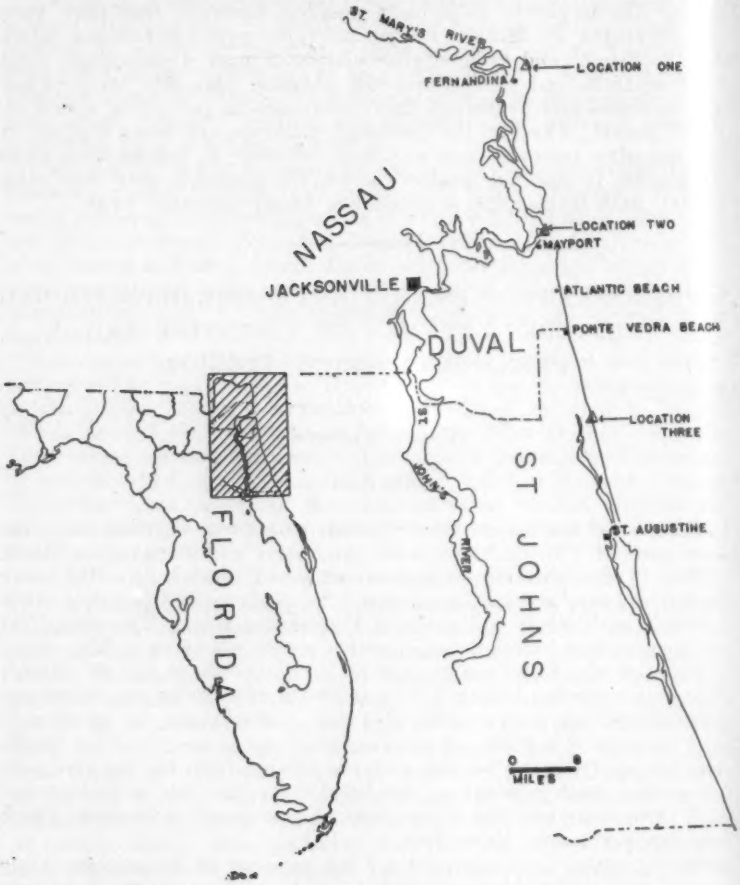
### Introduction

Samples of beach sand were collected from three locations along the east coast of Florida between St. Augustine and Fernandina Beach (Plate I). Samples one through seventeen were taken from the lower foreshore beach at location number 1, which is located one mile south of St. Mary's River and north of Fernandina Beach. The second set of samples was collected from aeolian ripple marks on a large dune formed on the jetty one-quarter of a mile north of the St. John's River at location number 2. The third set of samples was taken approximately ten miles south of Ponte Vedra Beach at location 3, and consists of a group of laminae from the lower foreshore beach, one sample from the lee side and one sample from the seaward side of aeolian dune adacent to the beach. The laminae in groups one and three were sampled to the zone of permanent saturation, which was approximately three feet.

The deposits were analyzed for the purpose of determining their composition and grain size preceding a more detailed study. It may be possible, upon the completion of this detailed study, to deduce some criteria by which ancient deposits of this type may be recognized, which would be of significant economic value.

Previous papers on this subject have been published by Martens (1935), Miller (1945) and Bateman (1954). A manuel published by Krumbein and Pettyjohn also treats of the subject. The heavy minerals of similar deposits are being extracted commercially near Jacksonville and Stark, Florida, by E. I. DuPont de Nemours Company. These heavy minerals are used in paint pigments, industry, and metallurgy.

PLATE 1. *Index Map*




## GEOLOGIC OCCURRENCE

The geologic occurrence of the heavy minerals in the beach sands and dunes along the east coast of Florida are described by Miller (1945), who worked in the area in 1945. The heavy minerals described in this paper are defined as those minerals which have a specific gravity greater than 2.88 and are found in the beaches along the east coast of Florida. This definition includes epidote, ilmenite, magnetite, monazite, rutile, and zircon. These minerals have been concentrated in discontinuous lenses, which range in thickness from mere films to three or four inches, by wave action and on the immediate

beach; these concentrations change with each reoccurring storm. The percentage of heavy minerals in the lower foreshore beach deposits varies greatly, giving the lenses, here termed laminae, an alternating light and dark appearance. The greatest concentrations occur in the dark laminae where the heavy minerals compose up to 25.6 percent (see table 1). The lighter laminae contain 1.3 percent heavy minerals, whereas the dunes adjacent to the beach at locations one and three, contain 3.3 percent. Contrary to field observations, the percentage of heavy mineral in the trough and crest of the aeolian ripple marks at location two varied only slightly, being 5.4 and 5.6 respectively.

TABLE 1
PERCENTAGE OF HEAVY MINERALS

| *Description of sample* | *% heavy minerals* |
|---|---|
| 1. Dark laminae at locations one and three | 25.6 |
| 2. Light laminae at location one | 1.3 |
| 3. Light laminae at location three | 2.0 |
| 4. Ripple marks on aeolian dune at location two | 5.5 |
| 5. Aeolian dune near location three | 2.0 |
| 6. Lee side of aeolian dune near location three | 5.1 |
| 7. Landward side of aeolian dune near location three | 2.8 |

## Laboratory Methods

The samples were analyzed as to size percentage by weight and percentage of heavy minerals by weight. A fifty gram sample was found to be a sufficient amount to give accurate results. A representative sample was quartered and weighed and sieved through Tyler screens with openings corresponding to the Wentworth Grade Scale. The sample was then shaken for five minutes on a Ro-Tap Automatic Shaking Machine. Each grade was then reweighed and percentage by weight determined. The heavy minerals were separated by running each sample through a separatory funnel containing Bromoform (Tribrom-methane) with a specific gravity of 2.88 at 23° C. The lighter minerals such as quartz and muscovite, floated in the Bromoform, because they usually have specific gravities of 2.66 and less than 2.80, respectively, whereas the heavier minerals (epidote, ilmenite, rutile, monazite, staurolite, and zircon) with a specific gravity greater than 2.88, settled to the bottom of the funnel and were thus separated. The mineral grains were then identified by optical methods using index of refraction liquids and physical properties.

## Size and Compositions of the Minerals

A brief description of the eight principal minerals will be given in order to acquaint the reader with their general properties. Quartz is by far the most abundant mineral and occurs as anhedral to euhedral, moderately rounded crystals marked by conchoidal fracture. Epidote locally occurs in moderately well rounded more-or-less distinct crystals that are elongated in the direction of the b-axis

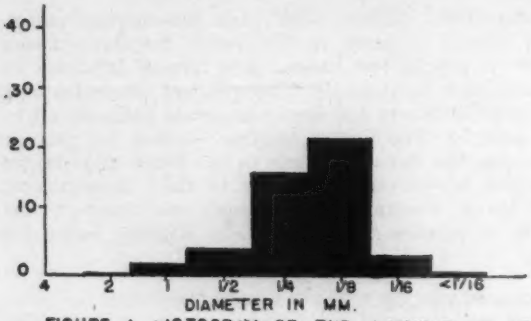



FIGURE 1. HISTOGRAM OF THE LAMINAE AT LOCATION ONE.

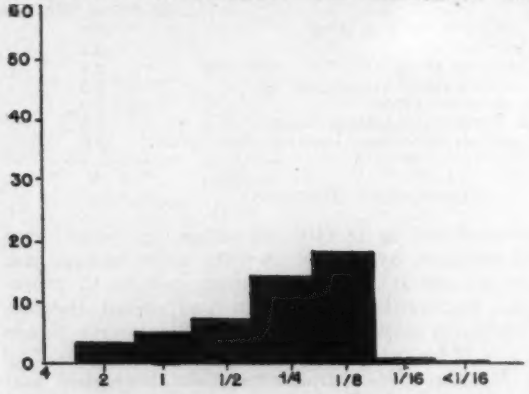



FIGURE 2. HISTOGRAM OF THE LAMINAE AT LOCATION TWO.

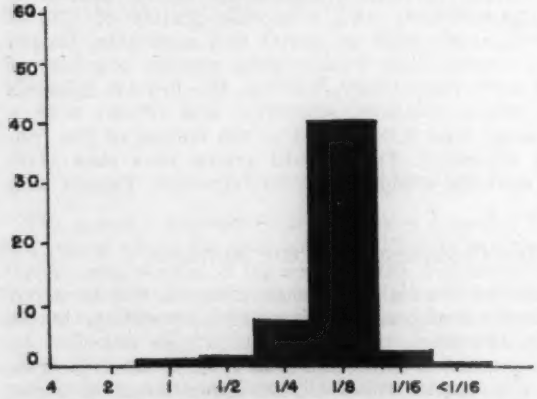



FIGURE 3. HISTOGRAM OF THE DEPOSITS AT LOCATION THREE.

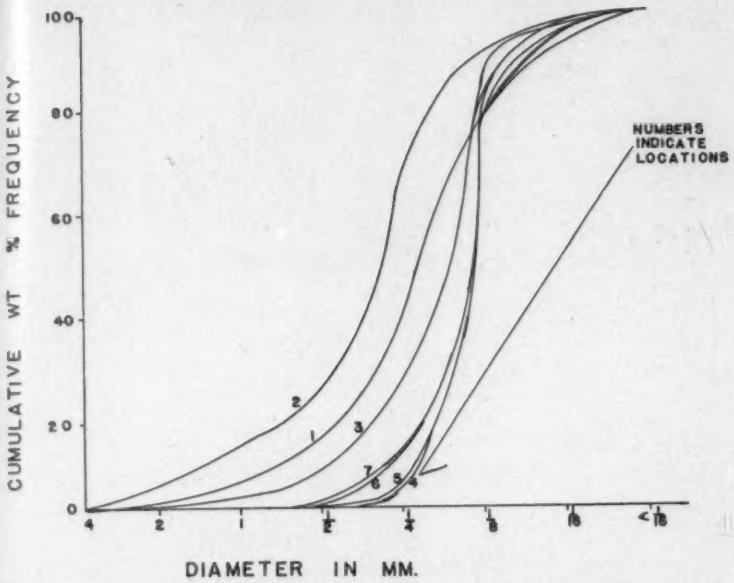



FIGURE 4. *Cumulative Curve of the Samples Discussed in This Paper.*

1. dark laminae at locations one and three
2. light laminae at location one
3. light laminae at location three
4. ripple marks on aeolian dune at location two
5. aeolian dune near location three
6. lee side of aeolian dune near location three
7. landward side of aeolian dune near location three

and have a psuedo-hexagonal cross section. Ilmenite has a metallic luster and is difficult to distinguish optically from magnetite; it is black in reflected light and alters to leucoxene. Magnetite is bluish black in reflected light and crystal facets are noted on some grains; it occurs in very minor amounts. Monazite is yellow-brown, has very faint pleochroism, and is well rounded due to crystal structure. Rutile is red, reddish brown to almost black with the red type most abundant and has high relief. Zircon is colorless and occurs as slightly rounded euhedral crystals of short prismatic habit. Muscovite is very sparse, colorless, and less than 1/16 mm. diameter. Minor amounts of corundum, garnet, calcite, tourmaline, and staurolite have been reported in previous studies, but none of these were identified definitely in this study.

The dominant grain size in the laminae at locations one and three is 1/8 mm. diameter with the heavy minerals being predominately smaller, i.e., 1/16 mm. diameter. The largest grains are those retained on the 2.00 mm. screen, and are of a minor amount. Figures 1 and 2 are histograms of the laminae at locations 1 and 2 respectively.

Figure 3 is a histogram of the aeolian deposit at location 3. It is easily seen that the deposits are well sorted and the dominant grain size is 1/8 mm. as shown in figure 4, which is a cumulative curve of the samples studied.

## CONCLUSIONS

1. The most abundant mineral, as might be expected, is quartz.
2. The most abundant heavy minerals are ilmenite, monazite, rutile, and zircon.
3. The heavy mineral suite also includes epidote and magnetite in lesser amounts.
4. Most of the heavy minerals have a diameter of 1/16 mm.
5. The unseparated samples are very well sorted (especially the aeolian dunes) and the grains have a diameter predominately of 1/8 mm.

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# A NOTE ON THE METHODOLOGY OF RESEARCH DESIGN IN OPINION RESEARCH*

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## THE PROBLEM

The present study is an outgrowth of a detailed and comprehensive previous study of the presumably "informed opinions" of seven separate groups of respondents concerning the current strengths and weaknesses of educational programs in hospital schools of nursing in the continental United States. In the previous contract research project, made possible by a special subvention of funds to the National Organization of Hospital Schools of Nursing from an anonymous foundation, the writer was confronted with the onerous task of devising and implementing an over-all research design which would furnish valid and comparable data about the "informed opinions" of the following seven groups of respondents: hospital administrators, directors of nursing, directors of nursing education, hospital medical personnel, faculty members, recent graduates of the hospital school of nursing, and third-year student nurses. The present paper discusses and illustrates the comparative merits and demerits of two major devices employed in the analysis of opinions held by the seven previously listed groups of respondents. These devices were:

(a) "Pre-categorized" items (i.e., items to which the respondent must reply by chosing from among several pre-determined response categories presented. In effect, this amounted to a modified "forced choice" situation.) See figure 1.

(b) "Open-end" questions (i.e., completely "unstructured" items which gave the respondent complete freedom of expression of opinion.) See figure 2.

## BACKGROUND OF THE PREVIOUS STUDY

An evaluation of the appropriateness of the research design of the previous study must be made in the light of the overall purpose of the study and in the light of the general conditions prevailing in the field of nursing education. A preliminary survey of the pertinent literature, supplemented by visitation in representative hospital schools of nursing and by interviews with presumed authorities in the field of nursing education and related disciplines, revealed findings which markedly influenced the research design of the study. It was found that the entire area of nursing, nursing education and

*Abstracted from a paper of identical title presented to the Section on Psychology and Medicine, Georgia Academy of Science, Athens, Georgia, April 29, 1955.

## INSTRUCTIONAL PRACTICES AND CONDITIONS

1. Evaluation of the general ADEQUACY or SATISFACTORINESS of instructional practices and conditions.

*Directions*: By appropriate checking, indicate your *personal* opinion concerning the instructional practice or condition listed.

TABLE # 3

| Instructional Practice or Condition Evaluated | Highly Satisfactory | Fairly Satisfactory | Not Satisfactory | Not* Applicable |
|---|---|---|---|---|
| 1. Objectives of instruction are clearly conceived and accepted by faculty and students | | | | |
| 2. General appropriateness of objectives of instruction | | | | |
| 3. Appropriateness and efficiency of teaching methods (over-all) | | | | |
| 4. a. Lecture | | | | |
| 5. b. Recitation, discussion, etc. | | | | |
| 6. c. Demonstration | | | | |
| 7. d. Laboratory | | | | |
| 8. e. Supervised practice | | | | |
| 9. f. Student conference (ward, etc.) | | | | |
| 10. Appropriateness of instructional material (over-all) | | | | |
| 11. a. Textbooks, journals, pamphlets, etc. | | | | |
| 12. b. Teacher-prepared materials (mimeographed handouts, etc.) | | | | |
| 13. c. Audio-visual materials (models, films, slides, etc.) | | | | |
| 14. Appropriateness and efficiency of the methods used in evaluating student learnings (over-all) | | | | |
| 15. a. Essay-type test | | | | |
| 16. b. Objective tests (True-false, etc.) | | | | |
| 17. c. On-job performance of students | | | | |
| 18. d. Student reports (case histories, etc.) | | | | |
| 19. e. Others (Fill in) | | | | |

*Check this column if the instructional practice or condition does NOT exist in or apply to your school.

2. In Table 3 (above) certain instructional practices and services are described and *numbered*. Refer to your checking of these numbered descriptions above as you fill in the information requested in the blank spaces below.

   a. Fill in the number of the statement describing the instructional practice or condition which you consider to be the MOST SATISFACTORY in your school ____ No.

   b. Fill in the number of the statement describing the instructional practice or condition which you consider to be the LEAST SATISFACTORY in your school ____ No.

FIGURE 1

SAMPLE PAGE FROM BASIC QUESTIONNAIRE ILLUSTRATING THE USE OF "PRE-CATEGORIZED" ITEMS

(Page 11)

GENERAL EVALUATION OF THE TOTAL EDUCATIONAL PROGRAM

*Directions*: In the space below, give *concise* answers to the following questions. In making your replies, consider all previous sections of the questionnaire.

1. What do you consider to be the THREE OUTSTANDING STRENGTHS of your total educational program?
2. What do yo uconsider to be the THREE OUTSTANDING DEFICIENCIES of your total educational program?
3. If you could have your WISH, what are the THREE MOST IMPORTANT CHANGES you would make in *your* school?

* * * * *

(Page 12)

"A LOOK AHEAD"

*Directions*: Give your *personal* reactions to each of the following questions.

1. Nursing education is *now being* done both in colleges and in hospitals. Give briefly *your* judgment about this situation, and your recommendations as to future developments. In your judgment, WHAT SHOULD BE the future role of (a) the hospital school of nursing? (b) the college or university school of nursing?
2. Most people have a "pet idea" about nursing education which they have not been able to carry out for some reason. *What is yours?* (Pretend for the moment you could do anything you wanted.)
3. In your judgment, how much freedom is permitted in planning and carrying out a program of instruction related to the objectives of nursing education advocated by *your* school?

FIGURE II

"OPEN-END" QUESTIONS EXCERPTED FROM PAGES 11 AND 12 OF THE BASIC QUESTIONNAIRE

the para-medical arts represented a scene of vast confusion, both intellectual and emotional. In addition to the conflicts of intellectual and emotional interests within the nursing profession, there were also evidences of status and other conflicts between certain groups of collegiate-trained nurses *versus* medical personnel and hospital administrators.

Among most of the prospective respondents there was little familiarity with, belief in, or competence in the use of rigorous research methodologies. Consequently, in view of a critical appraisal of the total research task involved and in the light of the results obtained from dry runs or pilot studies making use of two preliminary forms of a basic data-gathering instrument, it was decided that the final draft of the basic data-gathering instrument would place major dependence upon extensive and systematic use of pre-categorized items but would also make supplementary and specialized use of open-end items.

## THE COMPARATIVE ADVANTAGES AND DISADVANTAGES OF "PRE-CATEGORIZED" AND "OPEN-END" ITEMS

### *The Advantages of "Pre-Categorized" Items*

As based on experiential and theoretical considerations, the major advantages of the "pre-categorized" item appear to be these:

(1) In theory, at least, the construction of a complete data-gathering instrument which makes systematic use of "pre-categorized" items will have required the researcher to undergo a very complete, rigorous, and painstaking analysis of the total research task confronting him. That is, he presumably will have made an inventory of his general and specific curiosities, will have decided the particular kinds and amounts of data needed and will have made judgments concerning the form in which the data will need to be cast as an aid to analysis and interpretation. Thus, the researcher will perhaps typically have spent more time in the careful structuring of an instrument using pre-categorized items than is typically the case, or at least may often be the case, of the researcher who makes exclusive or major use of "open-end" items.

(2) On the assumption that the researcher has made a careful and painstaking analysis of the total kind and amount of crucial data required for the satisfaction of his curiosities, utilization of the "pre-categorized" item tends to permit and logically requires the respondent to consider every significant aspect of the total situation about which opinions are being requested. Ideally, at least, requiring the respondent to make a "forced choice" as between pre-determined categories need not bring about any distortion of fact or opinion—at least no more, if as much, distortion than would be required through the due application of routine data analysis procedures.

(3) Use of the pre-categorized type of item tends to facilitate appropriate quantification of data and also permits of direct comparability of the responses of varying respondent groups to an extent greater than that usually readily possible in the case of "open-end" items.

### *The Disadvantages of "Pre-Categorized" Items*

The major limitations involved in the use of pre-categorized items would appear to be these:

(1) It is almost literally impossible to provide on any schedule form for every conceivable contingency of data which might have pertinence to the research task. Consequently, schedule constructors typically make provision for such a lack of inclusiveness in the schedule by providing for "write-in" or "other" categories in addition to the items of data specifically listed. It is a common experience that the typical respondent will tend to ignore or make limited use of these provisions for "write-in" or "other" items.

(2) Some respondents appear to feel that the use of a detailed schedule which provides only for pre-determined categories of re-

sponse fails to allow sufficient freedom for the expression of precise and discriminating opinion. It is claimed that such a schedule tends to freeze the prospective response into a pre-determined mold and thus does violence at the source to the accuracy of data. It may be mentioned that this criticism is particularly valid unless extreme caution has been used by the researcher in selecting his choice of items for inclusion in the schedule and in the derivation of the pre-determined response categories.

(3) It may also be argued that the use of particular pre-determined response categories such as "highly satisfactory," "fairly satisfactory," and "unsatisfactory" may not have a common and constant meaning to all respondents since different respondents may attach varying interpretations and connotations to these labels. It is obvious, of course, that to the extent that wide variations occur among respondents in the interpretations placed on such pre-determined response categories, compilations of responses of a particular category may yield highly distorted conclusions.

(4) It is commonly recognized that it is extremely difficult, if not impossible, to devise a fixed schedule making use of pre-determined response categories which will yield a maximum output of "creative" or "productive" opinions. Such creativity and productivity are much more likely to result from the use of "free" as contrasted with "controlled" associations. The freezing and inhibiting effects of unrecognized habitual modes of response is seldom fully appreciated by the psychologically uninitiated. The use of "brain storming" techniques by Osborne and others in the Air Force and in industry is richly illustrative of the potential creativity and productivity of ordinary individuals when they are freed and unfettered from conventional restraints. It will be quickly appreciated that Item 3 of Page 11 and Item 2 of Page 12 of the printed schedule (see Figure 2) were particularly designed to stimulate such creativity and productivity. It may also be mentioned in passing that these two items yielded a very prolific and rich return of opinions.

### *The Advantages of "Open-End" Items*

The major advantages of the "open-end" type of item may be briefly summarized as follows:

(1) When properly phrased, such items clearly imply a lack of coercive and inhibiting controls over the replies of the respondents. That is, there is a freedom to express every possible variation of opinion and emotion. This freedom from exact and precise directions concerning the scope and quality of the respondent's reaction to the stimulus question in effect enables the item to serve a "dredging" function. Experience has shown that some of the responses thus dredged will contain logical "gems of the purest ray serene"; other responses apparently consist mainly of sludge and other material of little or limited usefulness insofar as its cruciality for the testing of the original hypothesis is concerned.

(2) Freedom from the requirements of a "forced choice" situation

enables the respondent to make fine and exact discriminations, involving a careful weighing of the pros and cons of a particular situation.

(3) A carefully phrased "open-end" item may stimulate creative and productive responses to a much greater extent than is ordinarily possible through the use of pre-categorized items.

(4) The alert investigator, through a critical analysis and interpretation of the phraseology and word choice of the respondent, may gain valuable clues concerning the depth and quality of feeling displayed. He may thus be enabled to make important differentiations between responses which are highly charged emotionally and those which reflect an attitude of objectivity and emotional detachment. The careful researcher will be particularly alert for examples of name calling, invective, irony, sarcasm, vituperation, allegation, and innuendo.

*The Disadvantages of "Open-End" Items*

In contrast to the presumed advantages of the "open-end" item as enumerated above are certain disadvantages, among which the following are typical:

(1) Many respondents who have rather carefully followed the instructions involving the use of the pre-categorized items fail to respond to one or more of the "open-end" items. Subsequent conferences with such individual respondents indicate that these failures to respond may be due to one or more of the following considerations:

(a) The time required for the mechanics of writing out a detailed reply discourage persons who state that their time is too crowded or too valuable to permit of such responses.

(b) One gets the impression from interview material that some respondents who have plenty of time for the mechanics of writing fail to respond because of the mental efforts required for the painstaking analyses and evaluations which would be involved.

(c) It is also apparent that certain failures to respond are due to a sensitiveness on the part of the respondent concerning his skill in spelling, sentence structure, grammar, punctuation, or lack of clear and forceful ideas on the topic being investigated.

(2) It is also noted that many respondents who furnish complete replies to the pre-categorized items tend to furnish impoverished responses to the "open-end" items. Such respondents tend to use a single word, phrase, or elliptical sentence as their only response. For example, in response to Item 3 of Page 12 concerning the amount of freedom permitted, many respondents gave answers such as the following: "None," "Adequate," or "Don't know."

(3) A third category of respondents to the "open-end" item tends to be quantitatively "over-productive." Such respondents tend to be quite prolific in their responses and in general tend to have a fine command of language. One gets the impression frequently that such respondents who are highly skilled in verbalization apparently are often aware of and proud of these verbal skills and that such re-

spondents tend to become so enmeshed in the web of their beloved phraseology that they express views which are suspected of being superficial or distorted—at least as compared with an analysis of the opinions of the same respondent as based on data secured from an interview situation or from responses to comparable pre-categorized items. The researcher must also be on guard against the tendency to weigh too heavily the responses of such verbally "over-productive" respondents. That is, if the analysis is made on a mere counting of the ideas enumerated, the volume of replies of these verbally facile respondents would tend to give a rather highly distorted sample.

(4) In addition to the disadvantages of the "open-end" item involving directly the *quantity* of the responses obtained, mention should be made of certain disadvantages more directly related to the *quality* of such responses. It has already been mentioned that when used as a semi-projective technique the "open-end" item becomes in effect a dredging instrument which often reveals material of irrelevant or otherwise doubtful quality. It should also be mentioned that the researcher is often hard put to derive on an *ex poste facto* basis suitable categories for the classification, analysis and interpretation of the responses obtained. Since unclassified and uninterpreted data tend to be worthless, this difficulty of categorization and interpretation is a very real and present one. It may also be mentioned that the arbitrary "forcing" of data into categories derived on a retroactive and *ex poste facto* basis may yield as much essential distortion as through the use of categories derived on an *a priori* basis.

## CONCLUSIONS

At the admitted risk of over-simplification of highly complex data and of too hasty generalization based on too meager data, a few conclusions concerning the methodology of opinion research are briefly stated:

(1) The investigator in the area of opinion research must carefully distinguish between "opinion about a fact" and the basic dimensions of the fact itself as separately determined from independent evidences.

(2) An "opinion about a fact" may have serious invalidity as measured by the criteria of "approximation of, or concurrence with, objective reality" and yet have marked validity for purposes of attempted human management—since individuals tend to react on the basis of subjective opinion rather than on the basis of objectively and validly determined reality *per se*.

(3) In general, there are two types of situations in which the researcher may wish to make use of both "open-end" and "pre-categorized" items:

(a) In one of these situations each of the two types of stimulus items (i.e., "open-end" and "pre-categorized") is conceived of as having rather sharply differentiated purposes. In this situation the "open-end" item is likely to have the major purpose of attempting to stimulate the respondent to engage in original, creative and pro-

ductive thinking or to reveal his basic feelings on the topic under investigation. The frame of reference for this type of creative thinking is more likely to be in terms of "what ought to be" rather than in terms of "what now is." Conversely, the "Pre-categorized" item makes little, if any, demand on the respondent for originality and creativity. Rather, it is the function of the pre-categorized item in this type of situation to enable the respondent to furnish, with a minimum expenditure of time and energy, a reasonably comprehensive and accurate picture of his opinions concerning a given *status quo* situation.

(b) In the second type of situation, each of the two types of stimulus items is conceived of as having identical or at least closely similar functions. That is, in both instances the emphasis is on obtaining an accurate and valid estimate of the opinions held by respondents concerning a given *status quo* situation. In this second type of situation, the "pre-categorized" item perhaps should usually receive major emphasis, with the "open-end" item being used mainly for corroborative and supplementary purposes.

(4) There is no royal road to truth and there are no fool-proof, rule-of-thumb research procedures available to the investigator in the area of opinion research. Rather, he must in each instance, in the light of his hypothesis, devise a research design of data collection and data analysis best calculated to furnish data of adequate quantity and quality for a crucial testing of that hypothesis. The ability to devise and to implement such a design is a measure of the ingenuity and general research competence of the individual investigator.

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## MANNOSE UTILIZATION BY *PSEUDOMONAS FLUORESCENS*

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During the course of investigations on the metabolism of *Pseudomonas fluorescens*, it was observed that under certain cultural conditions large quantities of a polysaccharide were produced. This polysaccharide was subsequently demonstrated to contain mannose sub-units. A preliminary report of this work has already appeared (Eagon and Randles, 1954. Bact. Proceed., pp. 100) and the study of this polysaccharide *per se* will be published at a later date.

During the study of the synthesis of this mannan, however, some interesting side observations on the metabolism of mannose were uncovered. Any unique mechanism for polysaacharide production by this organism was unlikely and some preliminary studies of the mechanism involved suggest a relatively normal pathway involving a phosphorylated mannose. Thus both the rate and extent of oxidation of mannose by 48 hour mannose-grown cells were lower than

for fructose or glucose. In the presence of 2, 4-dinitrophenol (M/2000), these differences were abolished and mannose oxidation approached that of the other two sugars. Glucose oxidation was essentially unaffected by this inhibitor, while fructose oxidation was influenced to a small degree (Table 1). The greater degree of oxidative assimilation with mannose is presumed, although not proven, to be due to the synthesis of the mannose polysaccharide.

Consistent with the above data is the apparent metabolic relation of these three sugars as indicated by enzymatic adaptation experiments (Table 2). The pattern of adaptation is clearly suggestive of the scheme:

$$\text{mannose} \longrightarrow \text{fructose} \longrightarrow \text{glucose}$$

Whether the sugars or their phosphorylated derivatives are actual participants in these conversions by *P. fluorescens* is unknown. No success has as yet been achieved in demonstrating phosphorylation of mannose directly, nor, for that matter, with any of the hexoses.

TABLE 1
EXTENT OF OXIDATION OF HEXOSES AND INFLUENCE OF 2,4-DINITROPHENOL

| Substrate | $O_2$ Uptake | |
|---|---|---|
| | No DNP | M/2000 DNP |
| Mannose | 104 | 158 |
| | 98 | 140 |
| Fructose | 130 | 158 |
| | 139 | 167 |
| Glucose | 120 | 130 |
| | 130 | 135 |

Phosphate buffer, 0.067 M, pH 7.0; 2 μmoles substrate; Temp. 38°C. Figures indicate μliters $O_2$ uptake with endogenous values subtracted. Two experiments recorded. Washed cell suspensions from cultures in mannose media employed.

TABLE 2
RELATIVE RATES OF OXIDATION OF HEXOSES BY CELLS GROWN ON THE DIFFERENT HEXOSES

| Substrates | $O_2$ Uptake 10 min. Cells grown on | | |
|---|---|---|---|
| | Mannose | Fructose | Glucose |
| Mannose | 18 | 0 | 2 |
| Fructose | 20 | 25 | 2 |
| Glucose | 40 | 33 | 43 |

Same conditions as Table 1. Cells from different growth media standardized to same turbidity on Klett-Summerson colorimeter.

# A SIMPLIFIED DROSOPHILA REARING TECHNIQUE

J. J. Paul[1] and D. L. Jacobs[2]

The little fruit fly (vinegar or pomace fly), *Drosophila melanogaster*, Meig., as well as other species of flies in the same genus, can be reared on many different media each of which has particular advantages. Many such media, although efficient in the production of adult flies, require a great deal of time and some equipment in their formation. Experiments were conducted in order to provide a simple, cheap yet efficient means of producing Drosophila adults for a variety of purposes. The basic formula and method employed was developed at the Bam-A-Sal Research Center by the junior author as a means of rearing flies for food for fish, small reptiles, amphibians, etc. The method was verified and further refined for entomological research by the senior author.

## THE CULTURE MEDIUM.

The culture medium is composed of several common household staples. These are:

| | |
|---|---|
| Powdered Confectioners Sugar | 1 part |
| Corn Starch | 2 parts |
| Dry Active Yeast | 2 parts |

The materials are mixed together in the dry condition. A mold inhibitor, such as Tegosept "M," may be added to control the growth of molds when the food mixture is prepared with water for use. It is extremely important that no more mold inhibitor than is necessary to control mold be added, since too much of it will prevent the growth of yeast which is essential to the fly larvae. Any amount of this dry Drosophila food mixture can be prepared, stored and used as required. When needed, the food mixture is mixed with water in the ratio of one-half teaspoon of food mixture to four teaspoons of water. A small quantity of absorbent cotton is placed onto the wet mixture and allowed to become thoroughly saturated with it. After the cotton is saturated, it is turned over so that any concentration of yeast on the bottom will then be uppermost.

## CULTURE CHAMBER.

Milk bottles, although they are convenient for use as culture chambers, are somewhat cumbersome since the flies either need to be shaken out of the bottle or the bottle needs to be darkened so the flies will crawl upward into another container.

A very good and easy to handle culture chamber consists of two glass parts (Fig. 1). The bottom part is a jar of the size and shape used for the packaging of peanut butter (squat one pound). The mixture soaked cotton is placed (or prepared) within this jar. The

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FIG. 1. *Rearing Chamber for Drosophila and Other Insects*

upper part is an inverted lantern chimney. The narrow end of the chimney fits well into the neck of the peanut butter jar. The broad end of the chimney is capped with the lid from a round ice cream carton. The lid is provided with one hole loosely plugged with cotton to facilitate the addition of water, or yeast, and to permit ventilation. Pairs of adult flies are placed into the chamber and either left there to mate and deposit eggs or they may be transferred to another similar chamber after four or five days.

## METHOD OF HANDLING FLIES.

The flies may be handled easily by simply placing two pieces of glass between the chimney and the culture jar. One piece is left to cover the jar, the other forms the floor of the chimney to prevent the escape of flies.

The flies may be etherized easily within the chimney by placing anesthetizing either or blowing carbon dioxide gas into the cotton plug in the lid on the chimney. The subdued flies will fall onto the glass plate and can then be handled at will as needed.

At least two generations of flies can be reared in each culture set-up before it is necessary to discard the cotton in the jar. Dry

active yeast and water can be added through the hole in the lid if conditions warrant.

The same technique will work well for other forms which are reared in culture media. The same equipment has been used for rearing houseflies, Indian meal moths, and mosquitoes.

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